



Future Aircraft Carriers

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**High Power Electronics
SiC Proposers Day**



Solid State Power Substation (SSPS) Shipboard Integration

- **CVN 21 Characteristics**
- **Potential Advantages**
- **Potential Aircraft Carrier Applications**
- **SSPS Testing Plans**
- **Technical Constraints**



CVN 21 Program Ship Improvements

Integrated Island

New Propulsion/Electric Plant

■ CVNX 1

■ Brought Forward from CVNX 2

■ NEW

<u>KPP CVN 21</u>	<u>Threshold</u>	<u>Objective</u>
Sustained SGR	160	220
Surge SGR	270	310
Service Life Allowance	5% Wt / 1.5 ft KG	7.5% Wt / 2.5 ft KG
Interoperability	Attain Critical IERs	Attain all IERs
Electrical Capacity	2.5X NIMITZ	3.0 X NIMITZ
Manpower	500 reduction	900 reduction

Improved Weapon & Material Handling

Advanced Weapons
Elevators

Heavy
UNREP

Enhanced Flight Deck

Underwater
Protection

Dynamic Armor
Protection

Improved Survivability

Enhanced Ship Self Defense

ESSM

4 EMALS
#4 CAT Unrestricted

Hangar
Bays (2)

Aircraft Elevators (3)
Stbd Sponson Redesign

Advanced
Arresting Gear

Enlarged Flight
Deck Footprint
"Pit Stop"

DBR

JPALS

Composite Mast
with Clamp
Antenna

All Electric Aux Services

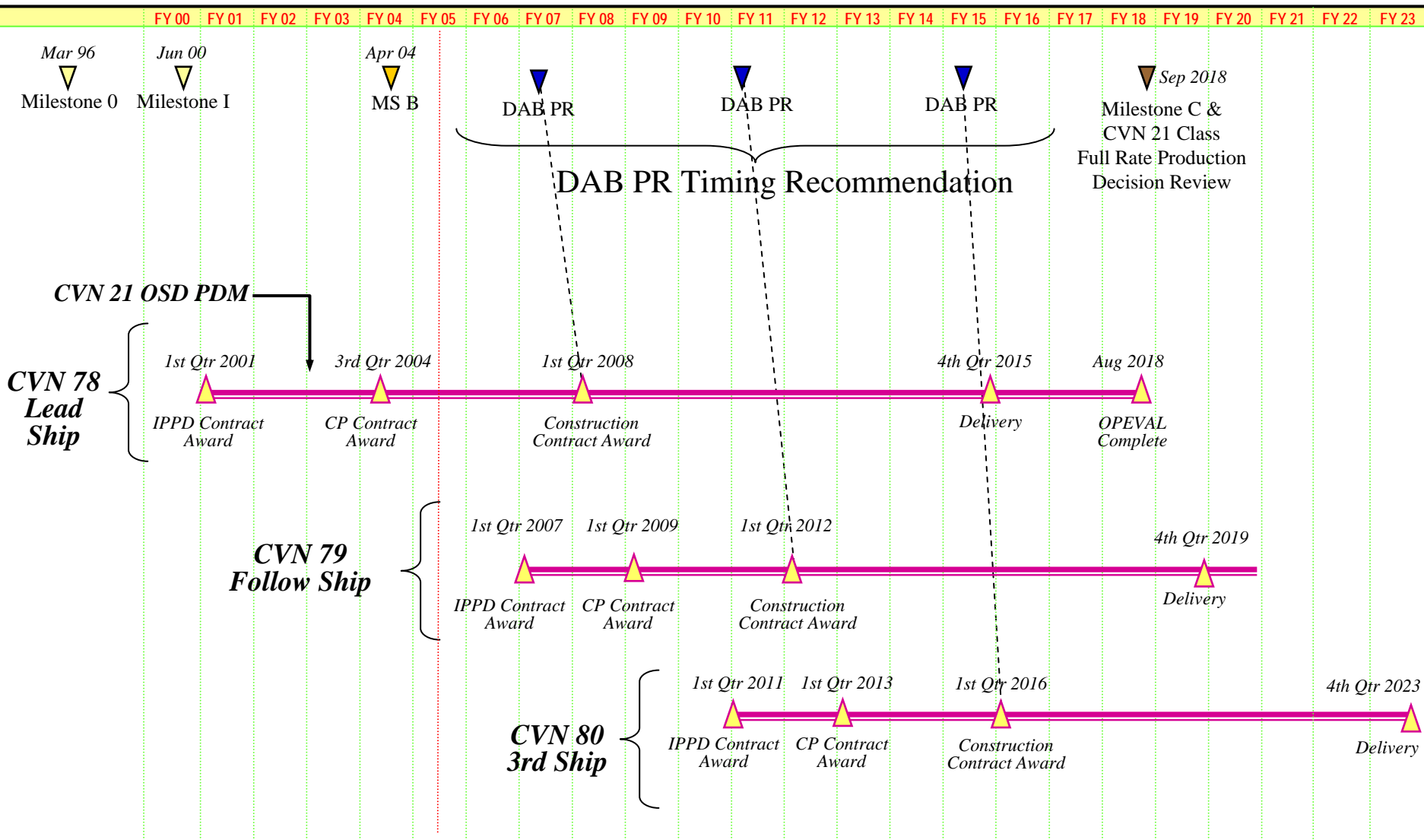
Zonal Electrical
Distribution System

New Propulsion
Plants

Smaller Island
Re-Positioned
Aft & Outboard



Program Schedule





Potential Advantages

- **Reduced Weight** – Should be able to significantly reduce weight compared to conventional power conversion components such as iron-core electromagnetic transformers.
- **Reduced Device Count** – Using higher voltage rated Silicon Carbide (SiC) power devices in a power converter may reduce solid state switch device count compared to using traditional Silicon devices for the same application.
- **Enhanced Electrical Distribution System Performance** – Pulse width modulation of power converters offers electrical distribution system improvements such as reduction in reflected harmonics and power factor correction.
- **Future Developments** – SSPS could be a first step to a more nodal shipboard distribution system, reducing component count and potentially improving overall survivability. Needs further evaluation.



Potential Aircraft Carrier Applications

- **Replacement for Iron-core Electromagnetic Transformers** – Forty 15kV/450 VAC 60 Hz power conversion transformers in the CVN 78 electrical distribution system.
- **Other Power Electronics Applications** – Other carrier systems require power conversion, e.g., EMALS, AAG. SiC technology could be used to simplify power conversion in future ships.



SSPS Testing Plans

- Engineering model SSPS will be functionally tested at a Navy test site with the required facilities. Testing has been funded by PEO Carriers
- Test plan will be reviewed by the supplier, the Lead Design Yard, and the testing organization and approved by NAVSEA.
- The test scope will be similar to previous land based engineering testing of power conversion equipment, and will focus on functional and system interface performance.
- After the engineering model testing, the shipboard version of the SSPS will require final shipboard design qualification testing, for vital electronics equipment, as approved by NAVSEA.



Technical Constraints

- Based on shipbuilding schedule, CVN 78 ship design and construction will continue in parallel with SSPS development.
- To support shipbuilding plans, the SSPS would need to be form, fit, and function identical to the 15kV/450VAC power transformer.
- Transient and fault behavior would need to be compatible with the CVN 78 Class electrical distribution system.
- SSPS likely would need to be a modular design to support installation late in the shipbuilding program.
- Efficiency would need to be comparable to the electromagnetic transformer to support HVAC capacity.
- SSPS would need to meet the military shipboard requirements that apply to transformers and to shipboard power electronics equipment.